

# Electrical Hazards Avoidance



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# Electric Hazards

One of the greatest hazards encountered by tree workers

- Electric lines present at many jobsites.
- Direct or indirect contact
  - Shock
  - Electrocution
  - Serious burns

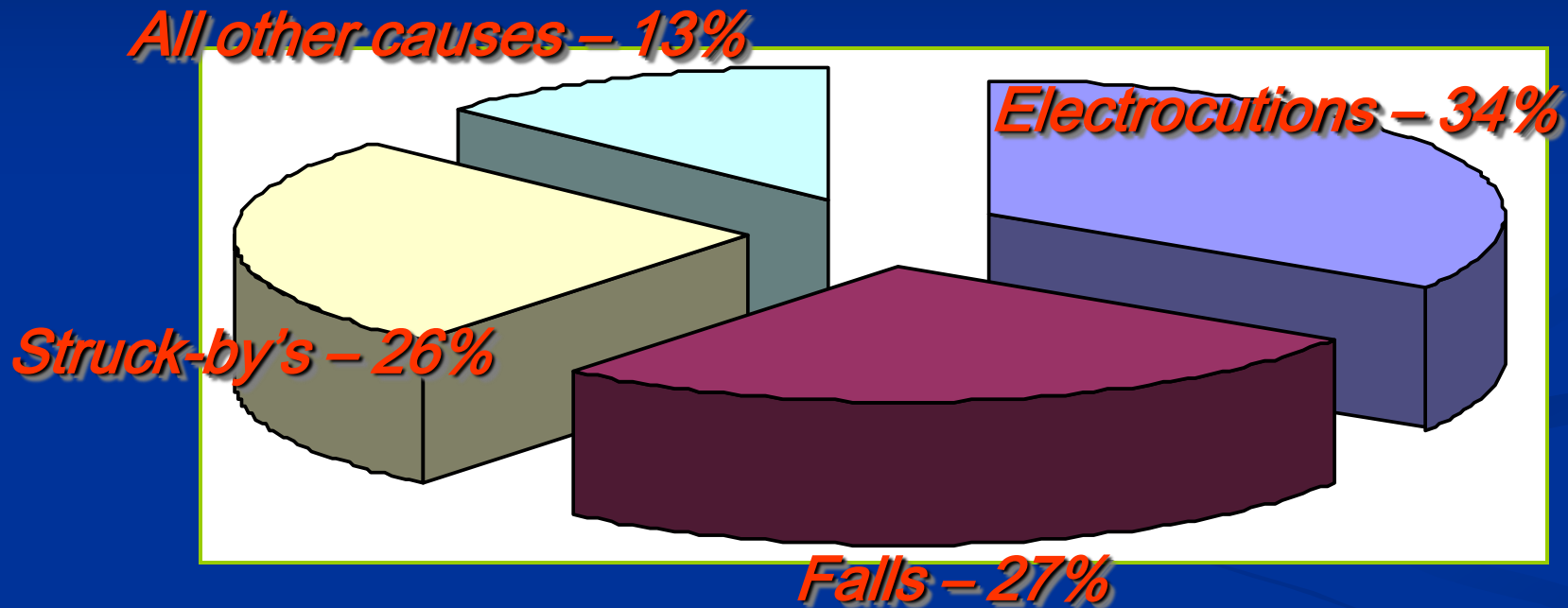


# Electric Hazards

Many in our industry fail to solicit or receive proper training



# Causes of Fatal Accidents



Between 1984 and 2002, federal OSHA recorded 106 fatalities in tree care.

# State and Federal Laws require training for workers who may encounter electric lines



- OSHA
- ANSI

# Attend EHAP Program

- Inform you about hazards when working around energized conductors
- Help you meet compliance requirements



# Laws and Regulations

## OSHA (Federal and State) and ANSI Z133.1

- All personnel must read, understand and be capable of effectively applying the applicable sections of OSHA and ANSI Z133.1 prior to conducting any work.



# OSHA General Duty Clause

Restrict job assignments near energized electrical equipment to employees who are “certified”



# OSHA Requirements

OSHA 1910.268(q): Regulates telecommunications line clearance workers:

- “Employees engaged in pruning, trimming, removing, or clearing trees from lines shall be required to consider all overhead and underground electrical power conductors to be energized with potentially fatal voltages, never to be touched (contacted) either directly or indirectly.”

# OSHA Requirements

OSHA 1910.333 and 1910.269:

- Cover workers near any energized electrical conductor during normal tree care operations
- Requires employers to document electrical hazard training

# OSHA Requirements

OSHA 1910.269: It is the responsibility of the employer to “certify” the competency of their employees . . .

- Job orientation and training
- EHAP course completion
- Other documented training (ex. climbing, pruning, rigging, emergency response)
- Supervised OJT training
- Demonstrate knowledge and proficiency

# OSHA Requirements

Other sections of OSHA, are also focused on line clearance work:

- 1910.269(a), (b), (c), (g), (j), and (p)
- 1901.67 (c) (2) (ix) and (3)
- 1910.151(b) and 1910.332.



# ANSI Requirements

## ANSI Z133.1-2006

- Safety Standard for Arboricultural Operations
- Tree care industry's consensus safety standard
- Referenced by OSHA and has force of law
- Annex B describes training required to achieve Qualified Line Clearance Arborist



# Key Definitions

Electrical conductor: “any overhead or underground electrical device capable of carrying an electrical current, including communications wires and cables, power lines, and other such fixtures or apparatus.”



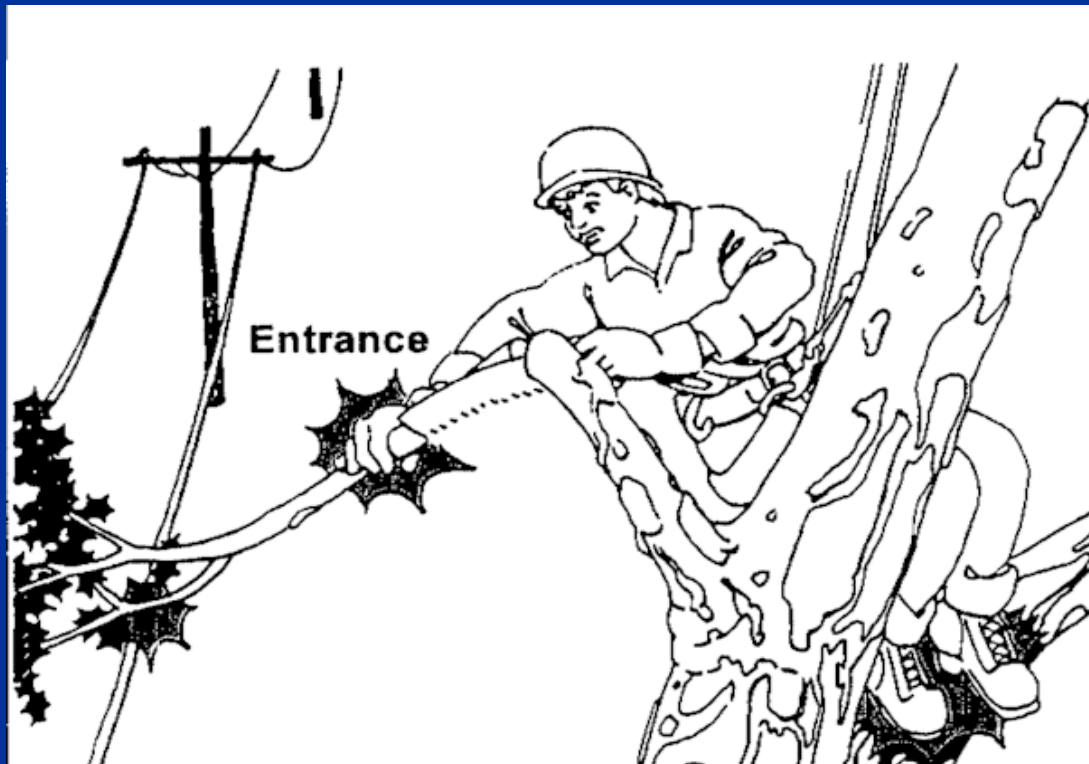
# Key Definitions

**Electrical hazard:** “an object or situation that poses risk of injury or death due to direct or indirect contact with an electrical conductor... specific minimum approach distances based on the arborist’s or worker’s level of training... shall be followed.”



# Key Definitions

**Indirect electric contacts:** When a conductive object in contact with person contacts energized electrical equipment permitting electricity to pass through the object and then through the person to the ground



# Key Definitions

**Qualified Arborist:** “An individual who, by possession of a recognized degree, certification, or professional standing, or through related training and on-the-job experience, is familiar with the equipment and hazards involved in arboricultural operations and who has demonstrated ability in the performance of the special techniques involved.”



# Key Definitions

**Qualified Line Clearance Arborist:** “An individual who, through related training and on-the-job experience, is familiar with the equipment and hazards in line clearance and has demonstrated the ability to perform the special techniques involved. This individual may or may not be currently employed by a line-clearance contractor.”



# Key Definitions

**Qualified Line Clearance Arborist Trainee:** “An individual undergoing on-the-job training under the direct supervision of a Qualified Line Clearance Arborist. In the course of such training, the trainee becomes familiar with the equipment and hazards in line clearance and demonstrates ability in the performance of the special techniques involved.”



# Qualified Line-Clearance Arborist

To work within 10' of energized distribution voltage equipment  
( $< 50\text{kV}$  - extra high voltage  $>$  distance)

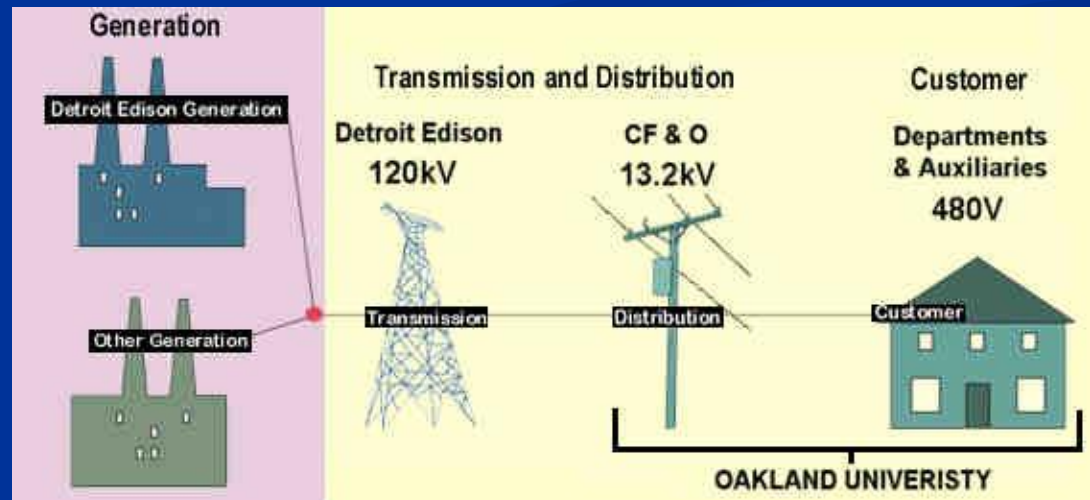
- Related training and on-the job experience
- Familiar with hazards in line-clearance
- Demonstrated ability to perform special techniques



# Qualified Line-Clearance Arborist

Qualification requires understanding of electricity

- How electricity works
- Recognize construction and hardware
- How utility system functions
- Special conditions and procedures required when working near energized wires
- Voltage = Minimum Approach Distance
- Demonstrated knowledge how to conduct work safely.



# Training Requirements

Employees know and understand how to apply basic electrical knowledge topics



# Training Requirements

Ensure employees able to identify the lines and equipment on a utility pole and structure



# Training Requirements

Ensure employees possess a working knowledge and proficiency in work safety standards and practices applicable to their job assignment



# Electrical Terms and Measures

Understand basic electrical behavior to best manage safety



# Volts

Voltage measures electrical pressure or force, not unlike water pressure generated by falling water



High voltage is similar to the high water pressure of a tall waterfall.

High voltage (used for transmitting electricity over long distances), like the force of a high waterfall, is extremely dangerous.

Low voltage can be compared to the low pressure of a small waterfall.

Low voltages, used in delivering electricity to the home - though dangerous - have less force than high transmission voltages



# Amperes

Amperes (amps) measure the volume or current flow of electricity, not unlike the volume of water flowing in a river



High amperage is similar to a river carrying a large volume of water.

Some electrical devices (in the home, electric stoves and air conditioners) draw a large amount of current. They have a high amperage.

Low amperage can be compared to the flow of water in a small creek.

Small electrical devices, like clocks, have a small amperage.



# Resistance (Ohms)

Ohms measure the resistance of a material to carrying electrical current.

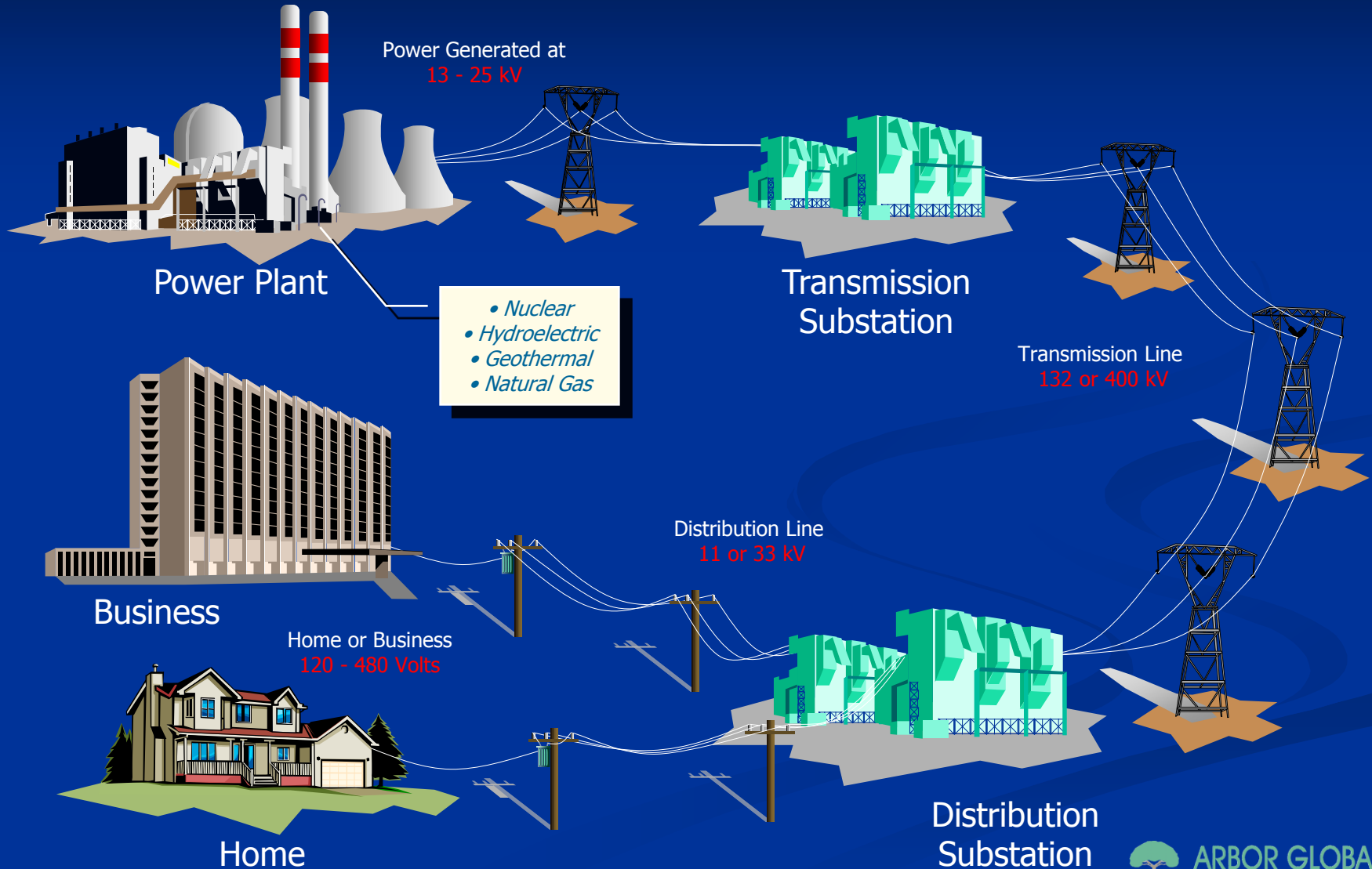


High resistance reduces the flow of current through a conductor, not totally unlike the effect of a rough riverbed.

Low resistance does not impede the flow of current through a conductor.



# Typical Electric System



# Transmission Line

- Carries high amounts of energy
- Operates at ultra high voltages (100 kV-525 kV or above)
- Usually on steel or concrete towers, but also very tall wood structures



# Substations

Large power transformers at transmission and distribution substations step down high voltages to sub-transmission and distribution voltage levels (4kV-100 kV)



# Primary Distribution Line

- Usually on wood poles or buried underground
- Typically, 2.4 kV-34.5 kV
- Delivers electricity to individual communities and industry



# Service Drop

- Goes from last pole into house or business
- Carries 120-600 volts
- Cable, TV and telephone have service drops
- Often buried underground



# Utility Pole Configuration

- Electric lines located highest on pole
  - Multiple voltages - highest voltage highest position
- Communications lines located lower



# Knowledge Requirement

Must recognize hardware to be able to:

- Understand equipment functions and energized status; and
- Conform to laws and regulations; and
- Comply with employer's safety requirements



# Conductor/Wires

## Covered Cable

- Secondary
- Primary
- Shielded (insulated)
  - Do not trust covering



# Insulators

Voltage indicated by insulator:

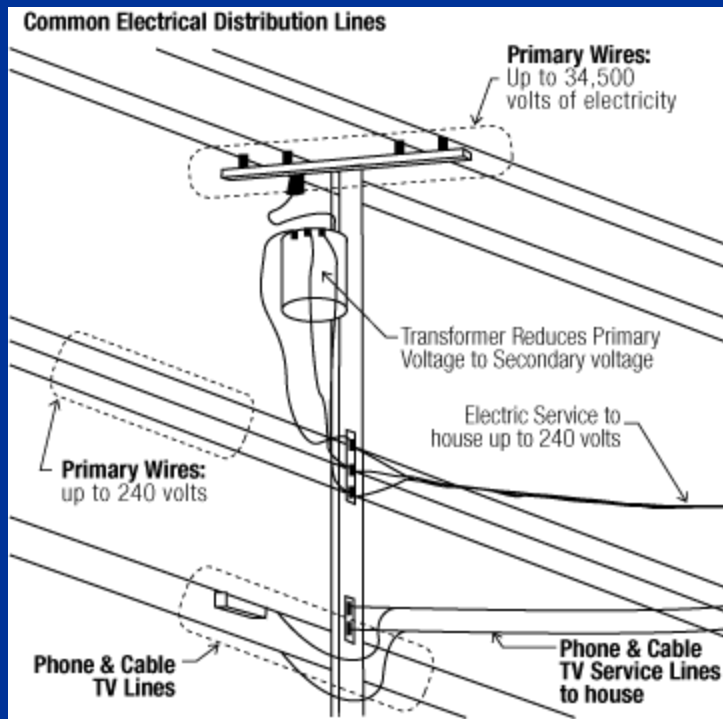
- Number
- Size
- Height of post or pin



# Telephone/Cable TV Line

Located under electric secondary lines

- Telephone usually on top
- Cable TV lowest line on pole



# Electrical Hazards

Electrical energy is constantly seeking  
a path to ground

People and trees are excellent paths

- People are best path



# Electrical Hazards

Before entering tree or commencing work on any site, an inspection shall be conducted by a Qualified Arborist to determine if an electrical hazard exists



# Electrical Hazards

An electrical hazard exists whenever:

- Any part of the worker approaches within 10 feet of any energized equipment
- Any part of tree being worked is within 10 feet
- Any part of tree will pass within 10 feet
- Any tool or equipment will come within 10 feet



# Electrical Hazards

All conductors (electric, telephone, CTV, guywires, etc.) shall be considered to be energized with potentially fatal voltages

- Other objects may be energized, especially after storms or accidents
  - guy wires, fences, telephone lines, highway barriers vines, trees, etc.
- Impossible to look at a wire or object and determine if energized and voltage



# Electrical Hazards

Low Voltage: 120 volts in house service can kill you

- Carries more than enough amps.



# Voltage Recognition

- Tree workers must be able to recognize maximum potential voltage
- Plan work accordingly – proper minimum separation distance



# Inspection

All Tree Workers shall inspect the tree and site to identify potential electrical hazard

- Utility
- Municipal
- Private
- Commercial



# Inspection

## Identify tree contacts

- Burned, brown leaves near conductors
- Ends of twigs and branches burned
- Unnatural notch or flat area in tree crown near conductors
- Burned wood in branch near conductor.



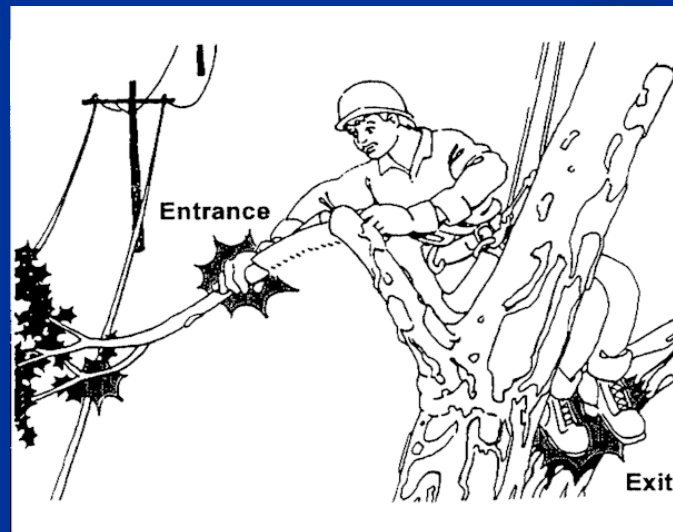
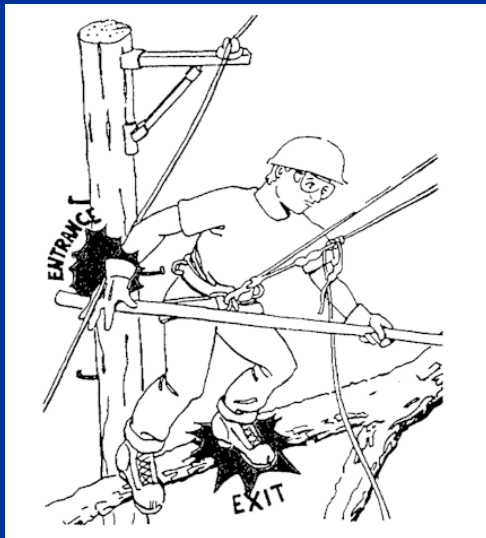
# Electrical Contact

## Direct contact

- Any part of the body touches an energized conductor

## Indirect contact

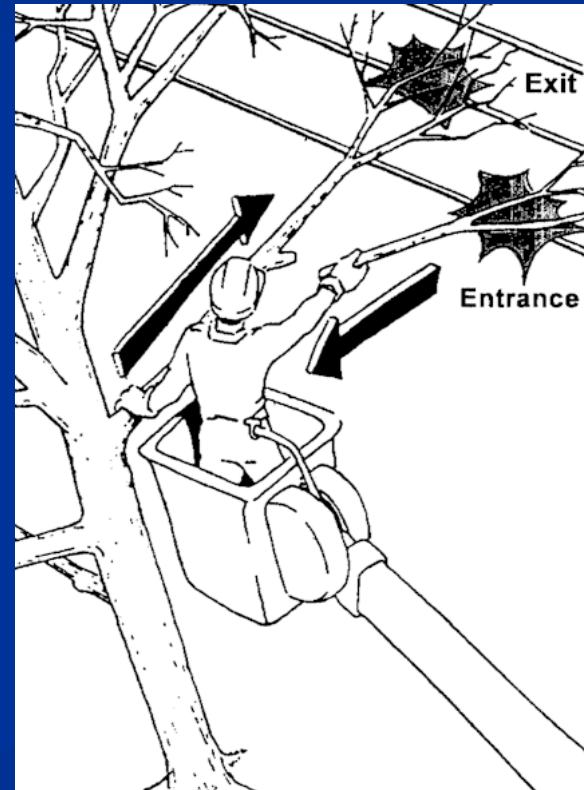
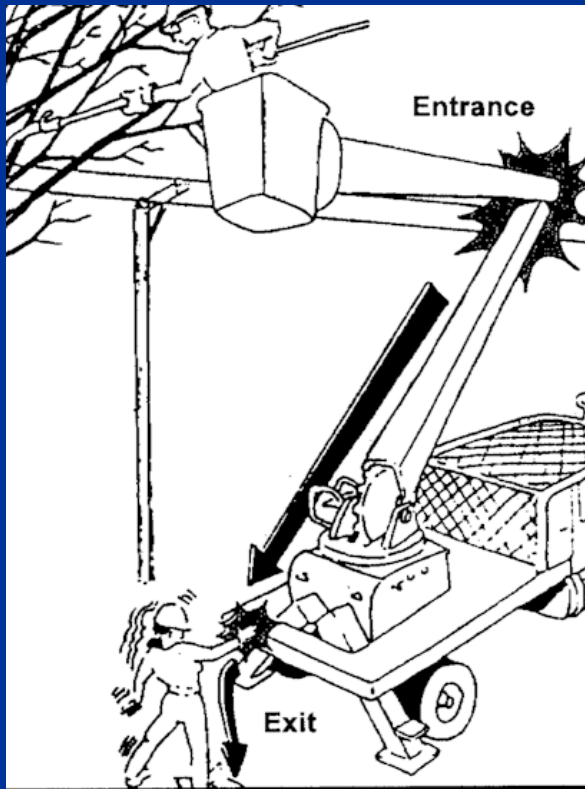
- Any part of the body contacts a conductive object in contact with an energized conductor
  - Tree limb, palm frond, tool, etc.



# Electrical Contact

Direct or indirect contacts may permit bypass of safety devices

- Insulated booms and tools
- Phase to phase or phase to ground contacts



# Electrical Contact

Physical contact may not be required under certain conditions

- High voltages
- Wet conditions
  - Rain
  - High humidity

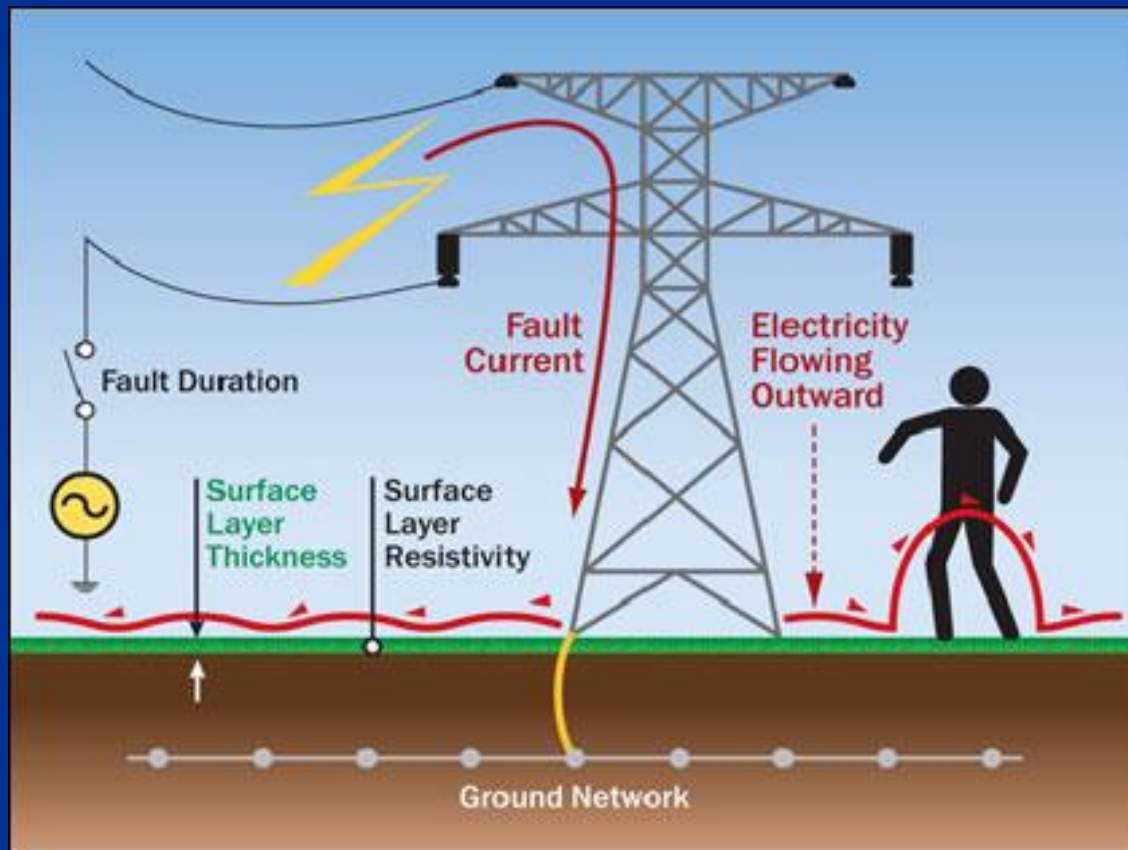
Electricity can jump (arc) to make contact and complete circuit

- Arc temperature can reach 10,000 degrees



# Electrical Contact

Step potential occurs when large amounts of electrical energy go to ground and create an uneven ground potential



# Working Near Utility Lines

If not contracted by owner/operator of energized electrical equipment (utility company, others)

- If qualified, must contact them prior to commencing any work within 10 feet of energized electrical equipment ( $>$  distance if voltage  $> 50\text{kV}$ )
- If not qualified, cannot conduct work within MAP



# Working Near Utility Lines

Wire coverings never considered insulated

- MAD for voltage always maintained



# Qualified Personnel

**ONLY Qualified Line-Clearance Arborists and Qualified Line-Clearance Arborist Trainees can work within 10' of energized equipment (Further for voltages > 50 kV)**

- All other workers must maintain at least 10' clearance at all times
- Includes:
  - Person
  - Tools
  - Aerial lift
  - Any part of tree being worked



# Working Near Utility Lines

Always maintain  $\geq$  Minimum Approach Distances

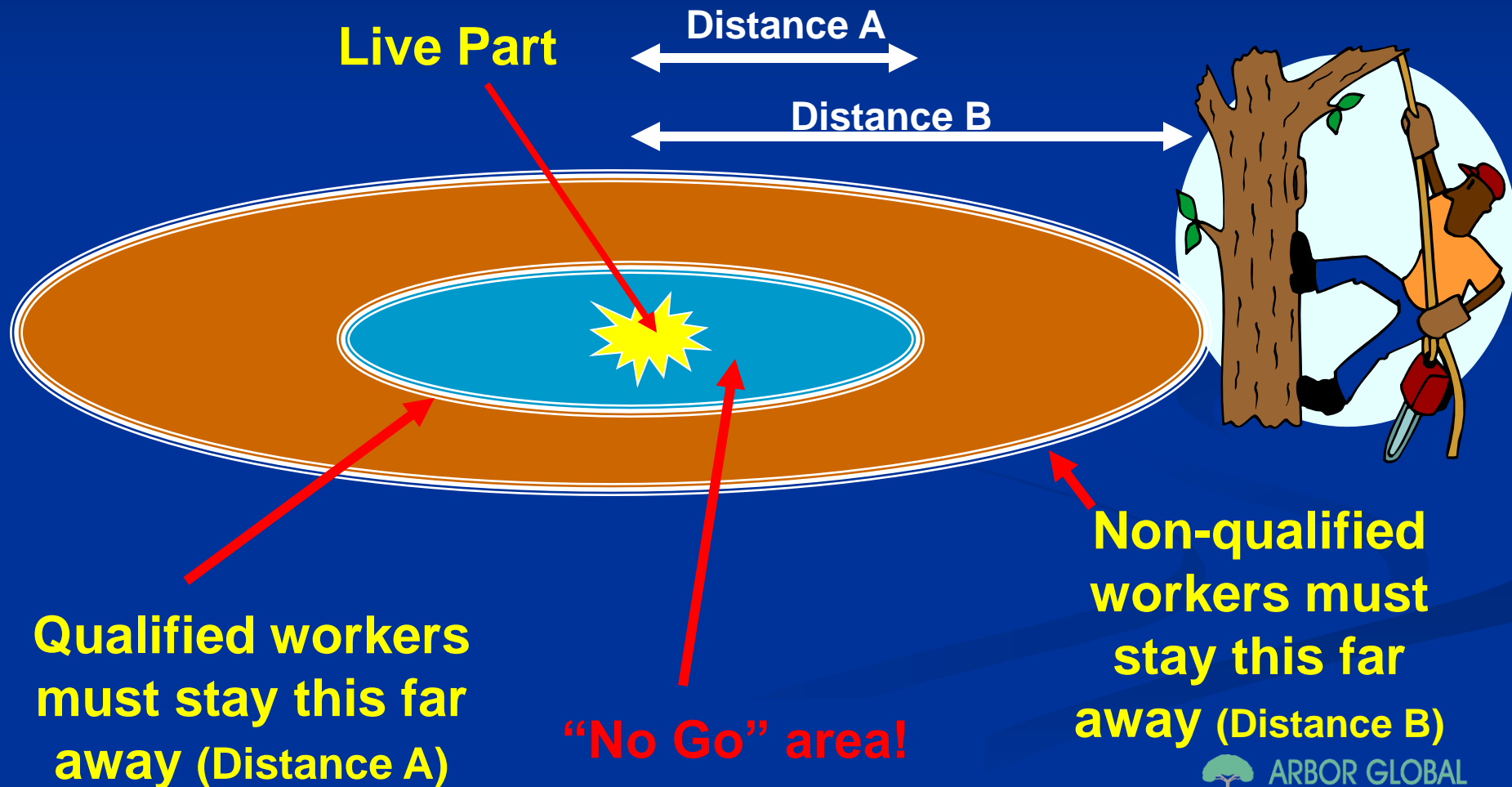


Diagram by Tree Care Industry Association

# Minimum Approach Distances Non Qualified Personnel

**Table 2 – Minimum approach distances to energized conductors for persons other than qualified line-clearance arborists and qualified line-clearance arborist trainees**

Nominal voltage kV phase-to- phase <sup>1)</sup>	Distance	
	ft-in	m
0.0 – 1.0	10-00	3.05
1.1 – 15.0	10-00	3.05
15.1 – 36.0	10-00	3.05
36.1 – 50.0	10-00	3.05
50.1 – 72.5	10-09	3.28
72.6 – 121.0	12-04	3.76
138.0 – 145.0	13-02	4.00
161.0 – 169.0	14-00	4.24
230.0 – 242.0	16-05	4.97
345.0 – 362.0	20-05	6.17
500.0 – 550.0	26-08	8.05
785.0 – 800.0	35-00	10.55

<sup>1)</sup> Exceeds phase-to-ground.

# Minimum Approach Distances for Qualified Line-clearance Arborists and Trainees

**Table 1 - Minimum approach distances from energized conductors for qualified line-clearance arborists and qualified line-clearance arborist trainees**

Nominal voltage in kilovolts (kV) phase-to-phase	Includes 1910.269 elevation factor, sea level to 5000 ft.*		Includes 1910.269 elevation factor, 5001 - 10,000 ft.*		Includes 1910.269 elevation factor, 10,001 – 14,000 ft.*	
	ft-in	m	ft-in	m	ft-in	m
0.051 to 0.3	<i>Avoid contact</i>		<i>Avoid contact</i>		<i>Avoid contact</i>	
0.301 to 0.75	1-01	0.33	1-03	0.38	1-04	0.41
0.751 to 15.0	2-05	0.70	2-09	0.81	3-00	0.88
15.1 to 36.0	3-00	0.91	3-05	1.04	3-09	1.00
36.1 to 46.0	3-04	1.01	3-10	1.16	4-02	1.09
46.1 to 72.5	4-02	1.26	4-09	1.44	5-02	1.30
72.6 to 121.0	4-06	1.36	5-02	1.55	5-07	1.68
138.0 to 145.0	5-02	1.58	5-11	1.80	6-05	1.96
161.0 to 169.0	6-00	1.80	6-10	2.06	7-05	2.23
230.0 to 242.0	7-11	2.39	9-00	2.73	9-09	2.95
345.0 to 362.0	13-02	3.99	15-00	4.56	16-03	4.94
500.0 to 550.0	19-00	5.78	21-09	6.60	23-07	7.16
765.0 to 800.0	27-04	8.31	31-03	9.50	33-10	10.29

\* Exceeds phase-to-ground; elevation factor per 29 CFR 1910.269.

Note: At time of publication, the minimum approach distances in this table for voltages between 301 and 1,000 volts exceed those specified by 29 CFR 1910.269, in anticipation of OSHA adopting these distances during the life of ANSI Z133.1-2006.

# Non-Qualified or MAD Not Possible

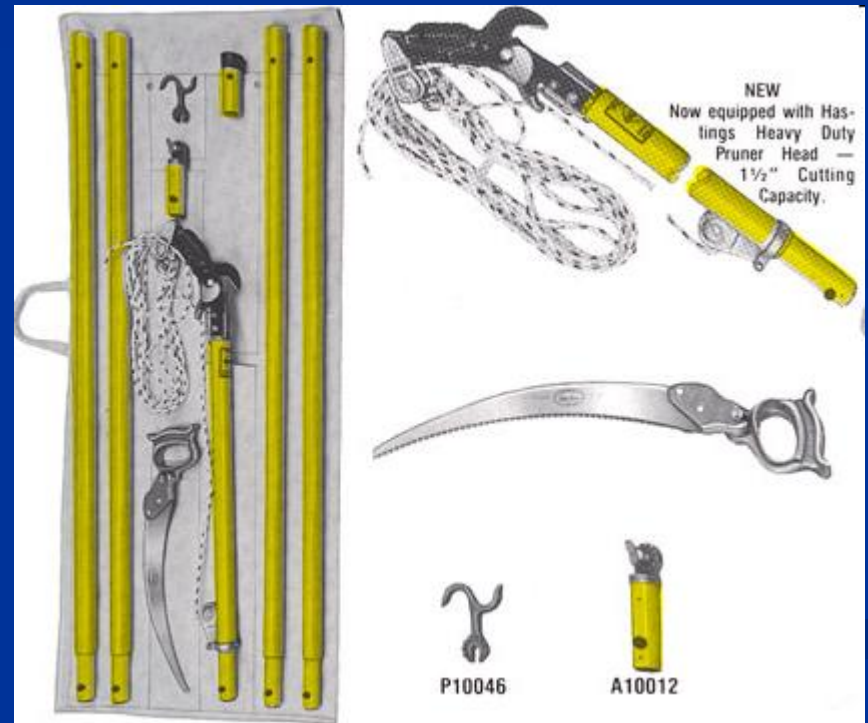
Contact equipment owner/operator

- De-energize and ground energized equipment
- Cover with insulated, protective covering to shield workers
- Move energized equipment away from worksite, outside MAP
- Conduct work by qualified line workers.



# Tools and Equipment

Use only tools and equipment designed, manufactured or approved for use near energized electrical equipment



# Tools and Equipment

Non-conductive tools must be kept clean and dry

- Dirt and wet increase conductivity



# Tools and Equipment

## Aerial lifts

- Inspected daily
- Cleaned with non-film cleaning agent
- Use only non-conductive hydraulic fluid
- Never alter bucket or boom
- Never fasten wire or conductive objects on boom
- Dielectric tested at specified intervals – ANSI A92.2
- Maintain MAD at all times



# Tools and Equipment

## Ladders

- Metal or other conductive materials shall not be used



# Tools and Equipment

Linemen's gloves, footwear or other electric resistant equipment shall not be considered as electrical contact protection



# General Work Practices

All work must always be conducted to avoid:

- Contact with energized electrical equipment
- Encroachment within the applicable MAD



# General Work Practices

- Maintain constant awareness of location of conductors
- Do not work with back to conductor
- Always know the location of the conductors and face that direction
- Do not conduct any work that cannot be completed safely.



# Aerial Lift Procedures

- Always face direction bucket is moving – toward lines
- Whenever possible, enter on side away from conductors
- Never squeeze bucket between conductors



# Aerial Lift Procedures

- Never drill holes in bucket
- Prevent groundperson from contacting truck and chipper until boom in safe position away from conductors
  - Do not operate the chipper until boom clear of lines



# Aerial Lift Procedures

Always maintain Minimum Approach Distances.



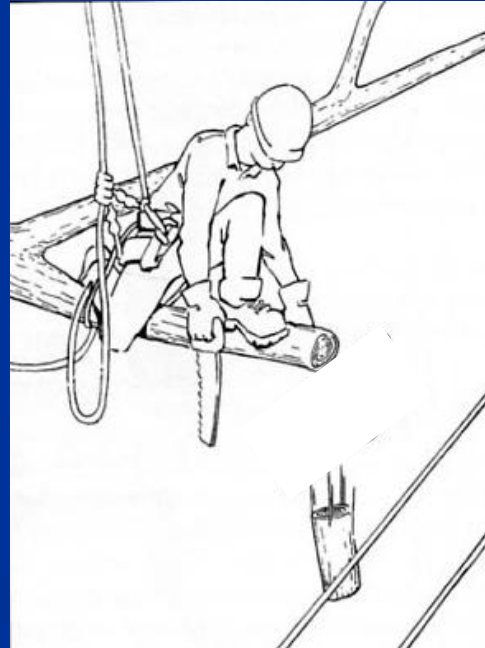
# Climbing Procedures

- Position tie-in to prevent entry within MAD
- Select tie-in that prevents swing into lines
  - Never tie-in over lines
- Whenever possible, climb on side away from conductors
- Do climb over lines
- Do not place weight on limb to cause line contact



# Pruning/Felling Practices

- Limbs that may contact conductors should be cut back first with a nonconductive tool
- If cannot be cut back, must be pulled back or lowered with a rope to prevent contact with conductor
- Cut short lengths of wood to fall between lines



# Pruning/Felling Practices

## Use ropes and equipment to control wood

- Control tree/limb to prevent contact with conductors
  - May permit removal of large limbs faster and safer
- Rigging most advanced tree work techniques
- Only experienced workers should perform rigging
- New techniques should be practiced before application



# Weather

## Weather can increase electric hazards

- Wet trees, tools and equipment become more conductive
- Wet atmosphere increases conductivity of air
- Wind can cause limbs and trees to move unexpectedly
- Use ropes to ensure fall control



# Weather

Extra caution and attention required during bad weather

- Increased risk of trees and conductors down
- Be alert for energized fences, fallen limbs, ground, etc
- Never assume that conditions are safe



# Weather

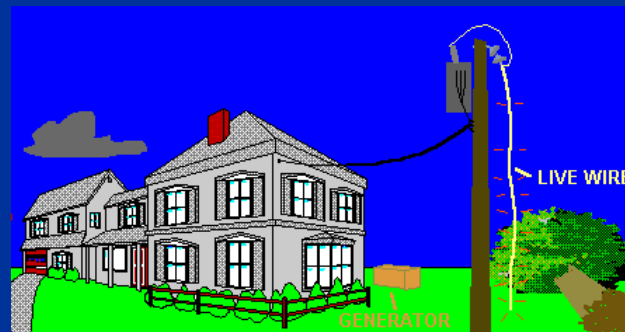
## Storm Restoration Work

- Work prohibited during storms
- Thorough jobsite inspection necessary
- Treat all downed lines as energized
- Fences, gutters, anything conductive can be “hot”
- Beware of generator feedback



# Generator Back-Feed Hazard

1. Storm knocks out electricity
2. Homeowner connects generator directly into house wiring without isolating it from in-coming lines
3. Electricity from generator “back-feeds” through house wiring breaker box, meter, house drop and transformer
4. Transformer that usually steps 7,200 volts down to 120 volts steps up 120 volts from generator to 7,200 volts sending it into storm-damaged distribution circuit
5. Unsuspecting arborist contacts tree or line and is electrocuted



# Underground Work

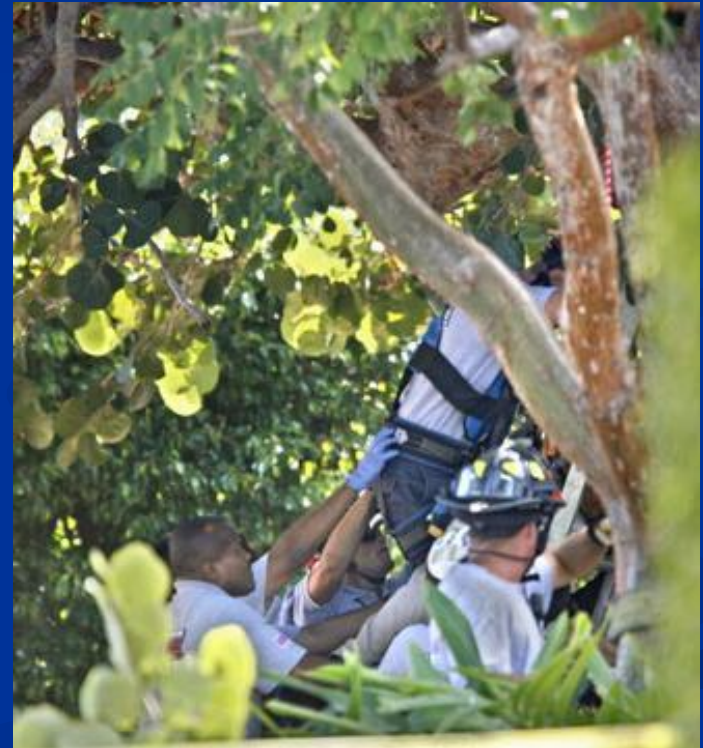
- Stump grinding
  - Trenching
  - Planting
  - Any digging
- 
- Facilities can be at any depth
- 
- Utility or locating service must be called.



# Electrical Accident Root Cause

The root cause of electrical contacts/accidents is:

- Inadequate inspection
- Lack of diligence
- Loss of control
  - Tools
  - Branches/fronds.



# Only Use Qualified Workers and Always Maintain Proper Minimum Approach Distance!



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